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The Advanced Photon Source Upgrade (APS-U): Interfaces in Complex Systems

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X-rays offer a unique opportunity to penetrate many complex environments to probe the structure and chemistry of surfaces and buried interfaces. These interfaces between media with distinct physical and chemical properties offer unique opportunities for discovery in diverse scientific areas such as catalysis, oxide film growth, semiconductors, geochemistry, surface physics, biomembranes, corrosion, nanoscience, environmental science, tribology, and electrochemistry.

A dedicated X-ray Interfacial Science (XIS) facility at a sector of the APS will fully exploit the unique capabilities of the APS to advance our understanding of interfacial science. The XIS facility will provide state-of-the-art x-ray scattering, spectroscopy, and microscopy tools for multi-length-scale, element-specific studies of vacuum/solid, gas/solid, liquid/solid, solid/solid interfaces, and supported nanostructures. The proposed facility has two optimized canted undulators producing four separate x-ray beams: one with variable energy and three with selectable fixed energies. In addition, the bend-magnet port will be developed to support those measurements that don't require the brightness of the ID beamlines. A tandem experimental hutch arrangement on each beamline will include both general-purpose diffractometers and custom-designed spectrometers to provide *in situ* controlled environment and growth chambers for various advanced materials processing and synthesis activities.

In addition to the proposed new sector, a canted undulator front-end source will provide a dedicated beamline for liquid surface scattering. This line will be tunable over the range 7–30 keV and will be outfitted with a custom liquid interface scattering instrument. Improved x-ray facilities for *in situ* surface and interface science will also provide enhanced capabilities for the ultra-high vacuum surface diffraction, and for molecular beam epitaxy surface science programs (surface x-ray absorption fine structure and surface resonant scattering).

The APS Upgrade provides new and enhanced x-ray facilities for *in situ* surface and interface science that will fundamentally change the paradigm for the study of the structure and properties at interfaces in fabricated systems as well as those found naturally in our environment. The opportunity to include integrated imaging techniques, time-resolved measurement capabilities, and the infrastructure to enable *in situ* experiments in very complex environments to probe interfacial processes holds great promises for discovery in interfacial and surface chemistry, dynamics, fundamental growth processes and fabrication, and nano-scale sciences.